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Mines and Quarries Department.

REPORT ON THE MINERAL INDUSTRY OF EGYPT.

Government Press, Cairo, 1922.

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CONTENTS.

CHAPTER. PAGE.
I.—Introductory ... 1
II.—Economic Geology ... 2
III.—History ... 5
IV.—Petroleum ... 8
V.—Phosphate ... 14
VI.—Manganese and Iron ... 18
VII.—Gold ... 22
VIII.—Lead and Zinc ... 24
IX.—Peridots and Nickel ... 25
X.—Soda ... 28
XI.—Alumina and Magnesia ... 30
XII.—Ochres and Pigments ... 32
XIII.—Nitrate shale ... 34
XIV.—Various Minerals not yet exploited ... 36
XV.—The Quarrying Industry ... 40
XVI.—Bibliography ... 47

Table of Mineral Production ... 50
Map showing Mining Localities ... *at end.*

THE MINERAL INDUSTRY OF EGYPT.

CHAPTER I.—**Introductory.**

The area of Egypt is approximately 1,000,000 square kilometres, of which 31,000 square kilometres comprise the cultivated area of the Delta and Valley of the River Nile.

The remainder, no less than 969,000, square kilometres, is desert, for the most part waterless and devoid of vegetation.

This desert area has no economic importance at the present day other than its mineral resources.

The known mineral deposits are few in comparison with the vastness of the desert area, but much of this is as yet practically unprospected and there is the probability of further discoveries being made.

These known deposits are mostly situated at great distances both from one another and from the River Nile, a fact which has retarded exploration and development. Considerable progress has, however, been made during recent years, notably on the coast of the Red Sea and Gulf of Suez. The sea affords the necessary facilities of access and transport, the lack of which so greatly detracts from the value of deposits situated in the interior.

Local interest in mining is small; this is owing to the fact that the population of Egypt is almost entirely engaged in agricultural pursuits and has no knowledge or experience of mining. The capital and organization of existing enterprises has, in consequence, been mainly supplied by foreigners.

The following chapters describe the various minerals, metals and precious stones which are found in Egypt and give details of the progress made in developing them.

The value of the mineral production for the year 1921 was approximately L.E. 1,300,000.

CHAPTER II.—**Outline of the Economic Geology of Egypt.**

The chief mineral deposits of the Egyptian desert fall naturally into three main geological divisions.

(1) The pre-Carboniferous, which is marked by volcanic activities and metamorphism.
(2) The pre-Miocene, consisting mainly of undisturbed sedimentary strata.
(3) The Miocene and post-Miocene, with folding and taulting.

(1) The area covered by formations of pre-Carboniferous age corresponds roughly to the area of the Red Sea Hills from latitude 29° N. extending southward into the Sudan.

The chief formations comprise :—

(*a*) The fundamental gneiss.

(*b*) The schists : a series of sediments and volcanic deposits (lavas, ashes, tuffs) formed during very early periods of the earth's history. This series has been invaded by great masses of granitic and other igneous rocks, which together with the accompanying earth movements have produced contact and regional metamorphism of a far-reaching character. Mineralization, when present, usually occurs near the junction of the schists with the intrusive granites. Gold, copper and emeralds are found in connection with the contact phenomena, while the igneous, ancient sedimentary and volcanic rocks have yielded a variety of good ornamental stones. Nickel ores and peridots are closely connected with a peridotite, and may belong to the period of the more modern Red Sea movements.

(2) Subsequent to the Carboniferous, and especially during Cretaceous and Eocene times, the gradual depression of land surfaces caused an advance, from the north, of the sea, which finally covered the greater part of Egypt.

The close of this period is however marked by the reappearance of shallow water sandstones and clays, indicating a re-elevation of the land, accompanied by volcanic intrusions.

The basalt of Abu Za'bal and red quartzite at Gebel Ahmar were formed during the latter part of this period. These conditions present a notable contrast to the pre-Carboniferous period.

The area covered by the pre-Miocene rocks is the characteristic desert plateau extending from the Red Sea hills to the Sahara. The rarity of folding and faulting in this area is unfavourable to the phenomenon known as "mineralization" or the segregation and concentration of minerals into deposits of economic importance, consequently, the pre-Miocene mineral deposits are mainly deposits of sedimentary origin.

Eocene and Cretaceous limestones are now the principal source of the building stones of the country, while the Nubian sandstone which outcrops from underneath them was mainly used by the ancient Egyptians for their temples.

The shales which immediately overlie the phosphatic zone alternate with the white limestone and are the nitrate-bearing beds of Egypt.

The important phosphate deposits which exist in layers between the Nubian sandstone and the white chalky Cretaceous limestones, are marine deposits of shallow water origin.

Extensive deposits of manganese and manganiferous-iron ores are found in Sinai in a small much faulted area of Carboniferous age. This area has been fully described by Dr. Ball.

The latest results have indicated that the major supplies of petroleum are connected with the strata which form the transition between the Nubian sandstone and the fossiliferous Cretaceous limestones, the fine sands holding the petroleum while the clays intercalated with them help to retain the oil.

(3) The Miocene and post-Miocene times were marked by the submergence of the northern area of Egypt extending southwards along what is now the Gulf of Suez and the northern part of the Red Sea.

The western portion of this area has so far proved barren of minerals, but in the comparatively narrow strip bordering the Red Sea deposits of importance occur. In this district is found a great development of the salt facies of the Miocene, with immense beds of gypsum, pointing to evaporation and chemical activity on a large scale.

Following the formation of these strata, we have at a relatively recent date the great earth movements, to which the Gulf of Suez and the Red Sea are due, together with the formation of subsidiary planes of weakness and underground channels of circulation in the zone bordering the main depression.

Recent work of the Geological Survey tends to emphasize the importance of folding in these great earth movements, during which the pre-Carboniferous granites, schists, etc., have been thrust in solid form through the younger strata. Anticlinal folds and domes have been produced in the course of these movements. Such structures are favourable to the accumulation of petroleum,which has now been proved to exist in commercial quantities. The petroleum is found in the finer sands, where they alternate with clays and form the transition from the sandstones to the limestones of Cretaceous age.

The main supplies of the Hurghada oilfield are from this source; the oil is of high specific gravity and viscosity.

The lighter oil of the Gemsa peninsula, on the other hand, occurs in a porous dolomitic limestone near the base of the Miocene formation.

Recent geological research has revealed indications of petroleum over wide areas in Eastern Egypt and Sinai. Drilling is now being done to test several promising localities.

Geological maps and further details will be found in the various publications of the Geological Survey.

CHAPTER III.—**History of Mineral Industry.**

Written records of mining for gold and precious stones are to be found among the earliest inscriptions. A papyrus in the Turin museum contains the first known examples of maps, and these represent Egyptian gold mines. There is also evidence that gold was worked in pre-historic times.

This mining is known to have been carried an at intervals by the early Egyptians of many dynasties extending over thousands of years, and in their turn by the Ptolemaic kings and by the Arabs until about 1300 A.D.

A gap of several hundred years then appears to have ensued, during which mining in Egypt was neglected, and not until the time of Mohammed Ali Pasha (1811–1848) do we find any further records.

The early records are chiefly of academic interest; they afford little indication of the value of the mines under modern economic conditions, but during the dormant period in Egypt Europe had made great progress in the practice of mining, metallurgy and geology, with the result that the various expeditions which were sent during the nineteenth century to investigate the ancient mines give us the first reliable information. Russegger, Caillaud (1819) L. de Bellefonds (1830–1831), Figari Bey (1884), Stewart (1886), Mitchell (1886), and Floyer (1888) have all left interesting records of their researches, but in no case did their exploratory work produce any material result at the time. Thus it was not until the beginning of the present century that actual mining recommenced.

The re-opening of ancient gold mines in Rhodesia started a wave of speculation in London and Paris which aroused interest in, and also provided the capital necessary for, the investigation of the ancient mines of West Africa and Egypt. This speculative activity was the cause of most of the uncultivated area of Egypt and the Sudan being divided up into huge concessions, which extended in practically uninterrupted succession from Sinai to Abyssinia. The pioneers in this movement were Bent (1895), Knox Brown, Haig, Johnson Pasha, and Alford (1900), who were interested in gold, Sir Elwin Palmer, who concerned himself with oil, and Monson, whose interest lay in phosphate and nitrates.

These early ventures resulted in a number of expeditions being sent to the various concessions to prospect and test the ancient workings. It was, however, at this critical time that interest began to flag at the centres of speculation, and a period of unprecedented activity in connection with West Africa was followed by a reaction which stopped the flow of capital for speculative gold mining. The concessionaires were for the most part individuals whose resources were insufficient to carry them over a period of depression, with the result that in several instances the concessions expired without having been thoroughly prospected, and in others, although valuable deposits had been discovered, capital for their development was not forthcoming. Moreover, it was found that initial difficulties of communication, water supply, and labour were greater than was anticipated, and that the ancients had exhausted the surface deposits, leaving much unremunerative work to be done before virgin ground for mining could be reached. Under these conditions it was not surprising that facts should have been misrepresented. In the first place the gold mining prospects were grossly exaggerated in order to attract capital, and again, when these unwarranted forecasts failed to materialize, all mining enterprise in Egypt was involved in the condemnation of its gold mines.

It had already been recognised by the Government that the concession system, as a means of developing the mining industry, was not producing the best results, and it had been decided to replace this system of granting mineral rights by one of general prospecting rights with powers to lease restricted areas. The expiration of the concessions was not therefore an unmixed evil. A period of quiescence ensued, during which a regular system of licensing and leasing on up-to-date principles was gradually brought into force, while at the the same time the public had leisure to review the situation and to realize that the mineral resources of Egypt do not consist only of gold mines.

CHAPTER IV.—**Petroleum.**

Oil was first produced in commercial quantities in Egypt in 1910, and up to the middle of 1914 the whole of the production came from Gemsa, where the average depth of the producing horizon was 1,500 feet in a fissured dolomitic limestone of Lower Miocene age.

In April 1914, a prolific gusher was struck; this came in at the rate of 3,000 tons daily and gave the total of 52,754 tons during the year. The average specific gravity of the oil was ·827 at 62° Fahrenheit. The well was, at first, beyond control and some of the initial production was lost. After eleven days the flow changed to a reddish-brown emulsion of oil, water and earthy matter. Thus all the wells drilled at Gemsa have eventually been invaded by salt water.

The source of this water has not yet been definitely settled; it comes in either at a separate horizon in very close proximity to the oil or possibly from the underlying Nubian sandstone formation. Attempts to exclude this water have failed up to the present, but should success be attained in a new producing well there is little doubt that considerable quantities of high grade oil are yet available on the coast of Gemsa headland.

An analysis of representative Gemsa crude gives the following :—

	Per Cent.	Sp. Gr. at 15·5°C.	Flash Point Degs. F.
Light petroleum spirit	19·54	0·7193	—
Heavy petroleum spirit	7·47	0·7698	—
Kerosene	32·43	0·8187	116
Residue—fuel oil	39·82	0·9014	290

The oil had a specific gravity of ·827 at 15·5°C., was dark greenish-brown in colour and contained 4·94 per cent paraffin wax (M.P. 117° F.), 0·63 per cent hard asphalt, and 0·65 per cent sulphur.

The productive zone at Gemsa has been along the foreshore and no bore placed at more than 100 metres inland has produced oil in commercial quantities. The successful bores are on the flank of a surface anticlinal structure the relation of which to the oil-containing formation at depth is not apparent.

The position at the end of 1913 was that 60,000 feet of boring for oil had been done at Gemsa and elsewhere in Egypt with a resulting production of 43,541 metric tons, and the whole of this production was from Gemsa.

In October 1914 prospecting well No. 1, which had been commenced in July 1913 at Hurghada, 35 miles south of Gemsa, came in at 1,670 feet with an estimated initial flush production of 1,500 tons daily from Upper Cretaceous sandy shales. Other wells were immediately commenced and soon proved that Hurghada offered great scope for rapidly increasing the crude oil production of the country, a fact rendered the more valuable by the outbreak of war. This prompted the concentration of drilling effort at Hurghada and its immediate neighbourhood by the Anglo-Egyptian Oilfields, Ltd., whose prospecting operations in Egypt have been the only ones, so far, to attain production.

The following are the statistics of drilling for oil at Hurghada :—

	Wells.		Wells.
1914	7	1918	12
1915	11	1919	13
1916	7	1920	11
1917	14	1921	8

There are two parallel anticlines at Hurghada known as the east and west anticlines respectively and it is from the western anticline that the production has been obtained. The sand beds here exhibit great regularity and the point at which production is to be expected can be fairly accurately judged in advance.

In his " Preliminary Report on the Chemistry of Egyptian Petroleum " Guthrie gives the following analysis of an average sample of Hurghada crude oil :—

	Per Cent.	Sp. Gr.	Flash Point Close Test.
Sp. gr. at 15·5° C.	—	0·9204	—
Petroleum spirit, light, B.P. below 120° C.	4·85	0·7142	—
Petroleum spirit, heavy, B.P. 120°-150° C.	2·88	0·7621	—
Petroleum spirit total, B.P. below 150° C.	7·73	0·7320	—
Kerosene, B.P. 150°-290° C.	14·24	0·8215	114
Residue, B.P. above 290° C.	77·21	0·9720	290
Water	trace	—	—
Common salt	trace	—	—

The oil is brownish-black in colour and contains 10·57 per cent asphalt and 7·73 per cent paraffin wax.

In one well on the western anticline a shallow oil was found at 700 feet and about 10,000 tons were extracted before water appeared and rendered further production unremunerative. This oil was not found in commercial quantity in any other well.

In 1917–1918 the Egyptian Government decided to interest itself more actively in the development of its oil lands and commenced geological research operations on both sides of the Gulf of Suez. The results of these expeditions are recorded in the Petroleum Research Bulletins Nos 1 to 10, while a note entitled " The Programme and Policy of the Government with Regard to the Investigation and Development of the Petroleum Resources of Egypt," was published early in 1921.

Had the discovery and development of the Hurghada field taken place in normal times considerably more attention would doubtless have been attracted, but it was not until

1919 that new comers began active prospecting over the long coastline of Egypt and on the peninsula of Sinai. In 1921 the D'Arcy Exploration, the British Sinai and other companies began to put drilling plant into operation on their newly acquired licences, and at the end of that year there were eight bores being put down in hitherto undrilled territory. The map of mining localities shows the wide extent over which the present prospecting operations are being conducted.

The following table represents the annual drilling done with the resulting production from all boring in Egypt from 1908 to 1921 :—

Year	New Wells drilled and drilling.	Feet drilled.	Wells producing.	Production (Metric Tons).		
				Gemsa.	Hurghada.	Abu Durba.
1908	2	1,415	—	—	—	—
1909	6	3,547	—	—	—	—
1910	19	18,506	4	2,793	—	—
1911	24	16,874	5			
1912	21	9,506	5	27,962	—	—
1913	14	9,059	6	12,786	—	—
1914	18	9,271	9	88,491	11,189	—
1915	17	11,319	8	13,144	16,910	—
1916	11	8,775	12	10,895	46,848	—
1917	15	8,317	14	6,875	129,970	—
1918	12	10,741	19	5,017	276,868	—
1919	14	6,754	21	4,234	227,686	—
1910	12	12,916	25	2,730	145,220	—
1921	26	22,657	31	4,209	178,284	175

Suez is the nearest port to the oilfield region and has naturally become the point upon which communications with the camps have been based. For many years the nearest prospecting camp to Suez has been not less than 100 miles down the Gulf, so that, in most instances, communication has been accomplished by steamer as offering a surer and quicker method of supply and transport than the native *gatira*. These sailing boats, of capacity varying from 10 to 100 tons, can, however, be chartered at Suez for approximately L.E. 1 per ton. A drawback to their use for heavy material such as boilers and engines is the lack of powerful hoisting tackle; on the other hand, their small draught frequently permits fairly close approach to a shallow water coast line.

No steamship company has, as yet, provided regular sailings to the mining ports, so that operating companies have generally supplied their own steamers.

Narrow gauge decauville railway is the most convenient form of local transport from the landing point to the site of the operations. One-ton Ford motor lorries, when lightly loaded, have been used with success for short runs over ordinary desert surface and caterpillar tractors have proved very useful for longer distances up to 25 miles.

State telegraph lines run down the Egyptian coast from Suez to Safaga *via* Gemsah and Hurghada, and down the Sinai coast from Suez to Tor *via* Abu Zenima and Abu Durba. Post offices are established at all these places with the exception of Abu Durba.

No reliable supplies of fresh water are found in the oilfields region, and fresh water has only been struck once in any of the deep borings; there are, however, possible sources of supply in the main wadis or dry river beds and prospectors might reasonably include a tube well equipment in their outfit. At present fresh water must either be brought from Suez or condensed from sea-water; no other source can be relied upon for regular supplies.

The system of drilling used at different times on the Egyptian oilfields have been: "Canadian pole," "Canadian wire-line," "Thom," "Standard Californian," "Holland mud-flush," "Galician" and "Rotary". The best results from the point of view of speed of drilling have so far been accomplished by the Standard Californian wire-line system.

Steam has been used as the motive power for drilling until recently, when the Anglo-Egyptian Oilfields, Ltd., has introduced the " Clark " benzine motor. This has proved particularly useful at outlying wells, to which it is difficult and costly to transport water for boilers.

Both at Suez and Ismailia repair facilities are good for those who do not wish to establish private workshops; at Suez, too, there is a dry dock, and at Ismailia a slip.

The tribesmen of the desert, being of nomadic habits, do not take kindly to regular work on the oilfields, but labour, willing and cheap, can readily be obtained from the villages of the Nile Valley. Mechanics are usually supplied from the European colony of the larger towns.

In 1921, 1,480 Egyptians and 127 foreigners were employed in petroleum mining in Egypt.

At the beginning of 1922 the area held under petroleum prospecting licences was 660 square kilometres, and 14 square kilometres were held under petroleum mining leases.

CHAPTER V.—**Phosphate.**

Deposits of phosphate of lime occurring as beds in sedimentary strata are widely distributed in Egypt.

They are very similar in character to those of Algeria and Tunis and present a field of considerable economic importance.

The principal places in which phosphate beds have been found are :—

Safaga district near the Red Sea coast;
Quseir district near the Red Sea coast;
Qurn district on the east of the Nile south of Qara ;
Hamama district on the east of the Nile north of Qena ;
Sebaia district on both sides of the Nile;
Kharga Oasis.
Dakhla Oasis.

Up to the present time the Government has leased 2,389 acres of phosphate-bearing land to various companies or individuals and has granted prospecting rights over a further 20,408 acres.

These are situated in the Safaga, Quseir and Sebaia districts, which have received the most detailed attention so far owing to their more favourable situation over the other districts as regards transport facilities.

The land thus leased forms a very small proportion of the total area which is known to contain phosphates.

The considerations which govern the actual and potential prospects of the phosphate mining industry may be classed under three headings :—

(*a*) The quality of the raw material;
(*b*) Economic conditions;
(*c*) The demand for and the saleability of the product.

(*a*) *The Quality of the Raw Material.*

The quality of the raw phosphate as found *in situ* varies considerably and contains from **30** to **75** per cent tricalcic phosphate. When phosphate is to be sold in the raw state to manure manufacturers the most saleable grade is 58 per cent and over, consequently the mines now being exploited in Egypt have been selected, other things being equal, from places where phosphate of the above quality is most in evidence.

(*b*) *Economic Conditions.*

The economic value of an ore depends upon the possibility of its profitable extraction at a given time and place.

As regards Egypt, the chief factor which governs such profitable extraction is cost of transport. Thus we see the commencement of the phosphate industry springing up in the Safaga and Quseir districts which are close to the Red Sea, and at Sebaia where the Nile is available for transport. The phosphate of the Qurn and Hamama districts are not quite so favourably situated, while those of the oases are so great a distance from the world's markets that their commercial exploitation is unprofitable at present.

(*c*) *The Demand for and Saleability of the Product.*

The demand for phosphate is likely to expand with advancement in the science of agriculture, with increase in the world's population and the more intensive cultivation necessitated thereby, especially in the older countries.

The world's production of raw phosphate amounts to about seven million tons per annum, the United States of America being the largest producer, which with Tunis together supplies more than half the total output.

Even assuming that there are no new discoveries, vast reserves of rock phosphate are known to exist, so that the marketability of the product is inseparably bound up with questions of freight and shipping.

When Egyptian phosphate is despatched from Red Sea ports to the East, Suez Canal dues are avoided, so that the commodity is able to compete favourably with Tunisian phosphate in Eastern markets. This consideration alone should ensure the future of successful exportation of the surplus production of Egypt.

The Manufacture of Phosphate Fertilizers in Egypt.

Practically all the raw phosphate marketed throughout the world is treated with acid and manufactured into superphosphate for the fertilizer trade.

Numerous processes for producing soluble or available phosphate have been devised from time to time and some of them give promise of commercial success.

Recently raw rock phosphate, finely ground, has been found in some places to give good results when used directly on land and the Egyptian Phosphate Company of Safaga has installed a mill for grinding its raw product to fine powder which, with the addition of a small proportion of certain other substances, is bagged and sold as " Ephos basic phosphate."

The Società Egiziana Fosfati is erecting a plant at Quseir with the object of manufacturing a somewhat similar fertilizer.

This same Società is also experimenting at Sebaia with another process which involves calcination of the raw material and produces a fertilizer known as " tetraphosphate."

Up to the present the high cost of imported acid has stood in the way of starting a superphosphate factory in Egypt.

The quantity of phosphatic manure needed for the soil of Egypt is stated to be comparatively small, so that a large proportion of the production of the mines must be exported.

The chemical composition of typical Egyptian rock phosphate may be quoted as follows :—

	Per cent.
Tricalcic phosphate	65
Iron and alumina	3
Calcium carbonate	10
Calcium fluoride	3
Insoluble (silica)	16
Moisture	3
	100

The following table gives the production of phosphate in Egypt since the inception of the industry in 1908. Normal expansion was arrested in 1918–1919 owing to accumulation of stocks.

Year.	Metric Tons.	Year.	Metric Tons.
1908	700	1915	82,998
1909	1,000	1916	125,008
1910	2,397	1917	115,732
1911	12,013	1918	31,147
1912	70,918	1919	29,365
1913	104,450	1920	114,813
1914	71,945	1921	122,024

Prior to the war the greater part of Egypt's phosphate production was shipped to Japan, which took 75,565 tons in 1914. During hostilities the quantity exported fell owing to high freight rates and the impossibility of obtaining sufficient shipping for the purpose. In 1916, for instance, only 20,526 tons were despatched out of a total of 125,008 tons mined.

The phosphate beds are mined in accordance with coal mining practice, the pillar and stall system being employed at Quseir and the long-wall system at Safaga, where compressed air and undercutting machines are in use.

During 1921 there were 1,912 Egyptians and 93 foreigners engaged in phosphate mining, and 2,389 acres were held on lease and 20,408 acres licensed for prospecting.

CHAPTER VII.—**Manganese and Iron.**

The manganiferous ore deposits of Sinai occur on the peninsula, principally in the district round lat. 29° N. and long. 33°·20 E.*

This is ten to fifteen miles inland from the coast of the Gult of Suez, where, a little to north-west, is the harbour of Abu Zenima.

The topography of the country is a mass of hills and ravines formed by the erosion of a plateau 2,000 feet above the sea-level.

The ore-bearing rocks belong to the Carboniferous series, which here consist of two sandstones divided by a bed of limestone or dolomite.

These carboniferous rocks were formed on the eroded surface of ancient schist, gneiss and granite.

The formation has undergone considerable faulting, which is connected with the occurrence of the manganese and iron ores found at the junction of the limestone and the lower sandstone.

These ores exist both in pockets and as a horizontal bed, ranging from a few inches to several feet in thickness, and can be followed outcropping around the steep sides of the ravines.

The principal minerals found are pyrolusite, psilomelane, manganite and hæmatite, all in close association and passing with every degree of gradation from a pure manganese ore to an almost pure iron ore.

The greater portion of the ore is thus a manganiferous-iron ore and the commercial consideration is the saleability of the grade which forms the largest proportion of the whole.

---

* *See* "Geography and Geology of West-Central Sinai," by Dr. Ball.

An average of some hundreds of samples gives :—

	Per Cent.
Manganese	35·0
Iron	23·0
Silica	2·95
Phosphorus	0·136

This is a typical manganiferous-iron ore, very suitable for the manufacture of spiegeleisen.

Mining Areas.—510 acres have been taken on lease, and prospecting licences granted over areas which aggregate 9,195 acres. This is indicative of the distribution of the ore. Much of this acreage will not, of course, be economically exploitable, but after due selection has been made there should be ample supply of ore to form the basis of stable mining enterprise.

Mining facilities in the Sinai peninsula are not unfavourable when compared with other parts of the world. Adequate labour can be obtained and its cost is reasonable. Water is scarce but can be shipped economically from Suez. The ore may be worked by adits and no expensive shaft-sinking is required. The transport, in any quantity, of the ore to a port, however, calls for considerable capital outlay, so that mining and shipping on a large scale is necessary to obtain the best financial results.

On the other hand, there is legitimate scope for individuals or syndicates, with only small capital at their disposal, to practice selective mining of the higher grade manganese ores where these occur in quantities which do not justify the erection of extensive plant.

Mining exploitation was seriously delayed by the war and the district passed for a short time into enemy occupation.

The Sinai Mining Company is the only operator which has yet reached the productive stage. The mines are connected with the seaboard by six miles of aerial ropeway and eleven miles of railway which terminates at the harbour of Abu Zenima, where storage ore-bins and mechanical loading facilities have been installed.

In 1921 there were 853 Egyptians and 26 foreigners engaged in manganese mining.

The production of maganiferous iron ore since the inception of the industry has been as follows:—

	Metric Tons.
1918	27,498
1919	48,734
1920	77,562
1921	55,065

Manganese ores are in demand for two distinct purposes. The steel metallurgist requires them for their metal content and the chemist wants them on account of their oxygen.

The consumption of manganese ores in chemical manufactures is small compared with the quantity used in steel making.

The sale of manganese ore is usually a matter of negotiation. Prices are quoted at so much per unit of manganese metal or of manganese peroxide according to the use to which they are to be applied, a unit being 1 per cent.

Importance is generally attached to the quantity of silica and phosphorus present in the ore and maxima are usually stipulated.

The two chief manganese alloys are :—

Ferro-manganese	75 to 80 per cent manganese.
Spiegeleisen	15 to 25 ,, ,,

The balance in each case is mainly iron, although the amount of carbon may be as high as 5 per cent. Manganese ore of good quality is necessary for the manufacture of the first and manganiferous iron ore is largely used for making the second.

When the ore is to be used for smelting purposes it is important that it should be supplied in lumps with as little fine ore and dust as possible.

The occurrence of iron ores, mainly hæmatite, widely distributed in different parts of Egypt has been noted from time to time by the Geological Survey, * but the absence of fuel has so far prevented commercial interest being taken in these deposits.

Ochres are described in a separate chapter.

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* "The Distribution of Iron Ores in Egypt," by Dr. Hume, 1909.

CHAPTER VII.—**Gold.**

The production of gold in Egypt has never been large in recent times. The great majority of the deposits known to have been worked by the ancients are small and patchy, and, though often containing exceptionally rich spots, are, generally speaking, more suitable for operation by local enterprise and small syndicates than by large companies.

The question of transport and water supply for Egyptian gold mines is complicated by their isolated positions in the desert and the fact that they are too small to bear the capital expenditure that would be necessary to overcome these difficulties.

The first battery of five heavy stamps was erected at Um Garaiat in 1904–1905 and produced gold to the value of approximately L.E. 100,000 in five years. A similar battery at Um Rus produced approximately L.E. 30,000 in two years.

In 1907 five light stamps were erected at Barramia under the management of Messrs. John Taylor & Sons. This battery was augmented by a further five heads in 1911 and by a small cyanide plant in 1917. The mine closed down in 1919 after running for twelve and a half years, during which time it produced gold to the value of L.E. 151,000.

The Um Tiour mine has been worked intermittently since 1912, but has produced only L.E. 11,237 worth of bullion.

At the Sukari mine, where the lode, both as regards size and promise of persistency, is an exception to the majority of small quartz veins on which the ancients worked, two or three attempts have been made to work under modern conditions, but partly owing to scarcity of water and partly to the low grade of the ore results have been unsuccessful.

The Atallah mine was reopened by a small syndicate in 1914 and was worked out in 1918 after producing L.E. 38,347. This is probably the only instance where a profit has been made in working an Egyptian gold mine during the last twenty years.

Attempts to work at Semna and Haimur have both been abandoned.

An interesting investigation as to alluvial gold possibilities was made by Hooker Pasha in the winter of 1916–1917 under Government auspices.

A valley bed of typical alluvium was selected in the Wadi Kurbiai not far from ancient alluvial workings, pits were sunk across the wadi and connected by crosscuts on the bed-rock. Ample samples were " dry blown " on a " shaker-blower " machine of West Australian type but the results were disappointing. Neither the alluvium nor the bed-rock were truly waterworn and the intermittent flood-water conditions under which the alluvium was laid down were apparently unfavourable to the concentration of the minute quantity of flaky gold distributed through the wash.

Whereas in 1919 there were 194 Egyptians and 11 foreigners, in 1920 there were only 37 Egyptians and 2 foreigners engaged in gold mining.

The production of gold in Egypt is shown in the following table; the rise in operating costs since the war has practically killed the industry for the time being, but it should gradually recover when the price of stores and transport falls.

Year.	Fine Ozs.	Year.	Fine Ozs.
1902	2,705	1912	4,958
1903	3,482	1913	4,602
1904	5,750	1914	6,136
1905	10,138	1915	7,096
1906	5,216	1916	6,287
1907	4,916	1917	3,319
1908	1,843	1918	2,856
1909	2,900	1919	1,948
1910	4,452	1920	128
1911	5,068	1921	*Nil.*

CHAPTER VIII.—**Lead and Zinc.**

The ancient lead mine at Gebel Rossas was reopened by the Compagnie Française des Mines du Laurium in 1912 and worked for four years, during which time mixed ores of lead and zinc were extracted as follows :—

	Metric Tons.
1912	3,510
1913	7,156
1914	4,909
1915	2,988

The mine is situated three miles inland to the west of the little harbour of Mersa Zebara, from whence the hand-picked ore was shipped direct to the smelters in Greece.

This Company having considerable experience in the exploitation of similar deposits was able to extract all the available ore at a minimum of expense and at a handsome profit.

The mixed ores consisted of carbonate and sulphide of lead and carbonate of zinc, and were found as a bedded deposit in the limestone underlying gypsum. The deposit occurs in a small anticlinal fold and is probably due to replacement in Tertiary times. Prospecting in the vicinity disclosed no extension of the original mine, but as such deposits do not necessarily outcrop at surface other similar occurrences may exist in the same district.

Lead ore in very small quantities has also been found at Ranga in gypsum associated with sulphur and iron pyrites ; at the Wadi Gasus in the Safaga district in limestone, and at Wadi Hamr near Aswân in schist. All these occurrences have been prospected from time to time, but without finding sufficient ore to encourage further work.

CHAPTER IX.—**Peridots and Nickel.**

The Egyptian peridot is the " Noble Olivine " of the gem trade. It occurs in beautiful flawless crystals of a typical and uniform deep yellowish-green colour which has earned for the cut stones the name of "Evening Emerald."

The mineral olivine is widely distributed, but a deposit at Zebirget, or St. John's Island, in the Red Sea is the unique source of the large deep coloured crystals. Cut stones often attain to twenty or thirty carats in weight, and occasionally very much larger crystals are discovered.

The Island, which has an area of about 1,200 acres, is mainly composed of peridotite which rises to a peak 230 metres above sea level. Small peridots may be found at several places, but the fine stones have only been found on the east side, where they occur in veinlets in a decomposed area of serpentinized peridotite. The veinlets, which run in all directions, form a species of stockwork covering a roughly oval area of several acres in extent. So far no attempt has been made to work this stockwork in bulk, the method of exploitation being to follow each vein separately from the surface as long as it continues to yield or until it dies out. The veins pinch out and become barren when they reach the unaltered peridotite. The size and quanity of the stones produced from different veins vary greatly, but the quality of the product is remarkably uniform. The continuance of the deposit in depth appears doubtful, so that as far as can be judged at present it seems likely that the supply of fine specimens of these unique gems is strictly limited.

Historical references to this stone show that it was known to the ancients, but that it has been confused at times with both the emerald and the topaz owing to the lack of precise nomenclature. The fact that specimens typical of the crystals from St. John's have been found in archæological excavations at Alexandria is sufficient evidence that the deposits were worked in ancient times. Carved specimens are known which would appear to date at least from Greek times, and the island is said to have been called " Topazius " by the Romans. Pliny also calls the stone " topaz." Arab writers appear to have confused the peridot with the emerald, and, though it is recorded that the emerald mines of Zebara and Sikait were reworked by them, they do not seem to have known that the peridot came from St. John's Island. On the other hand, Arabic nomenclature clearly distinguishes between " Zamurud " (emerald) and " Zerbirget " (peridot), and the Arabic name for St. John's Island is Zebirget.

The mines were formerly worked by H.H. the ex-Khedive of Egypt and were closed at the beginning of the war. The rough stones were sent to France for cutting and polishing. The mines are now held on lease from the Egyptian Government by the Red Sea Mining Company, but there has been no production since 1914.

As a gem the large stones have always been in demand, particularly for pendants. The smaller stones, which are naturally more numerous, are yellower in colour owing to their lack of depth. They also have a constant market, but the demand for both large and small stones is, to a certain extent, subject to fashion.

NICKEL.

Immediately to the south of the peridot workings and in the main mass of peridotite are two parallel nickel-bearing veins. Some of the peridotite in the vicinity also carries nickel values. The two veins strike approximately north-east and south-west, dip almost vertically, and are exposed on the surface for a distance of about 50 metres. Their average width is from two to three feet. The ore occurs in green and brown alternating bands and appears to be very similar in character to the garnerite ores of New Caledonia. The nickel content varies from 9 per cent to 5 per cent, the green ore being invariably richer than the brown ferruginous ore. It is interesting to note that a specimen analysed by the Imperial Institute was found to contain an appreciable quantity of platinum.

The area is leased to the Red Sea Mining Company. A very limited amount of development work has been carried out and the Manager estimates the ore immediately available to be five or six thousand tons. The production up to the present consists of trial shipments which were sold in France. These amounted to 75 metric tons in 1912 and 233 metric tons in 1914.

CHAPTER X.—**Soda.**

Sodium salts are widely distributed in Egypt, so widely indeed that they are more often a disadvantage to the agriculturalist than a benefit to the miner. The principal salts found are the chloride, the sulphate and the carbonates.

The chloride is obtained for commerce principally from the marine lakes on the shores of the Mediterranean Sea. The sulphate and the carbonates are usually in close association, and it is when large quantities are concentrated in one place that they become commercially interesting. Such areas of concentration are found at intervals throughout Egypt and the Sudan. The largest example in Egypt is the chain of soda lakes in the Wadi Natron and the second in importance are the natron lakes and *birkas* of Harrara in the Beheira province.

The lakes of the Wadi Natron have been described by Lucas in his paper entitled, "Natural Soda Deposits in Egypt," 1912. These lakes are leased to the Egyptian Salt and Soda Company and are probably the oldest known occurrence of natural soda in the world. The company makes caustic soda and soda ash and sells crude natron and salt. The terms of the concessions, however, do not provide for collection of statistics by the Mines Department.

The Harrara deposits are near the western edge of the Delta and are leased to Messrs. Blattner & Co. of Alexandria, who also manufacture from the raw material fine products such as washing soda crystals and pharmaceutic sodium sulphate.

The chief deposits at Harrara consist of two shallow lakes, the larger having an area of about 260 acres and the smaller one an area of about 20 acres.

The lakes, which are 35 to 40 metres below sea level, are formed in shallow depressions by water infiltrating from below. This infiltration occurs seasonally when the Delta becomes waterlogged by the high Nile about the end of November, and the waters gradually recede, leaving the lakes dry, or nearly so, about six months later. The water is impregnated with salts, principally natron and trona with some common salt and sodium sulphate; these crystallize out as the lakes dry up and are left on the mud bottom like a sheet of ice several inches thick. Variation in the solubility of the salt contents causes selective crystallization, which enables a rough sorting of the product to be made at the time of collection. The salt crust contains from 18 per cent to 40 per cent carbonate and 15 per cent to 42 per cent sulphate of soda. The salts are apparently renewed annually, but not so fast as they can be removed; thus the lakes were considered worked out and abandoned some twenty years ago, but in 1916 were sufficiently recharged to render exploitation profitable.

Recent output of mixed carbonates and sulphates from the Harrara district is as follows :—

	Metric Tons.
1917	3,527
1918	3,486
1919	1,431
1920	1,981
1921	563

CHAPTER XI.—**Alumina and Magnesia.**

Sulphate of alumina and sulphate of magnesia are both found under very similar conditions in the oases of Kharga and Dakhla.

The alumina deposits have been worked since the time of the Romans, who exploited the salt on a fairly extensive scale. Ever since then small quantities, perhaps 20 tons yearly, have been extracted and sold on the spot to the agents of the tanneries, who go to the Kharga Oases for the purpose.

The value of the magnesia salt does not seem to have been recognised till later.

Both salts occur in the clay and shale which overlies the Nubian sandstone and the aluminium sulphate is sometimes found in the upper portion of the sandstone itself. The salts are found in layers composed of delicate and closely packed fibres, the fibres being at right angles to the beds of clay or shale. The salt layers vary from one to eight inches in thickness, and often contain bands of sand or clay between two or three thin layers. This makes it difficult to extract the fragile mineral cleanly and the product as mined always contains a large proportion of waste matter. The overburden at existing workings varies from a few inches to six feet in thickness.

The salts are located by digging pits, but no reliable surface indications are apparent.

The magnesium sulphate contains less water than Epsom salts and the aluminium sulphate is more or less anhydrous. Occasionally the aluminium sulphate is coloured pink owing to the presence of cobalt.

Kharga Oasis is connected with the Nile Valley by a railway 180 kilometres in length, consequently only the Kharga deposits are worked, those of Dakhla being too remote for exploitation to be commercially profitable.

The production of the alumina salts was stimulated towards the close of the war owing to the difficulty in obtaining alum, for waterworks, from Europe.

Year.	Sulphate of Alumina.	Sulphate of Magnesia.
1918	168 metric tons	390 metric tons.
1919	54 ,, ,,	269 ,, ,,
1920	*Nil.*	266 ,, ,,
1921	*Nil.*	115 ,, ,,

CHAPTER XII.—**Ochres and Pigments.**

The pigments found in Egypt are essentially oxide of iron, in addition to which a little manganese is sometimes present.

The anhydrous oxide of iron has a very strong colour and may be used as " red oxide " or may be burned to produce colours variously known as " rouge," " indian red " or " venetian red."

The hydrated oxide of iron forms the group of colours known as the " ochres," " siennas," and " umbers," which vary between every shade of red and brown to pale yellow.

A vandyke brown which contains organic matter is also found in Egypt in small quantities.

Iron-stained rocks and clays abound in Egypt, and the purer forms of oxides and ochres generally occur in pockets or thin seams rather widely scattered.

The value of these oxides as pigments is due to their lasting qualities. They are used largely in the preparation of both water and oil paints and distempers. Distempers are made by mixing cheap or adulterated pigments with water containing a little glue to act as a binding agent. Such distempers are largely used in Egypt and are very permanent when applied to plaster, stucco, brick, or stone.

Colours of iron origin were much used by the ancient Egyptians and have doubtless been collected in Egypt from time immemorial, but in recent times the locally produced colours have been of the lowest grade and quite unable to enter into competition with imported paints.

The search for red oxide and ochres has been energetically taken up by Labib Effendi Nassim, who has discovered, in the Nubian series east of Aswân, a bedded deposit of red oxide having an exposure at surface extending for some 200 yards. He has proved that iron colours of the best quality can be made from local raw material and is erecting a factory near Helwân with fine grinding and roasting machinery. This is a great advance on previous local enterprise and gives promise of export trade as well as supplying the needs of Egypt.

The production of ochres during recent years has mainly been from the Aswân district and Kharga Oasis and was as follows :—

	Metric Tons.
1918	212
1919	44
1920	231
1921	430

CHAPTER XIII.—**Nitrate Shale.**

At the top of the Cretaceous formation in Egypt are the Isna shales and clays which underlie the Eocene limestone. These shales outcrop over a considerable area in Upper Egypt on both sides of the Nile extending from Qena to Mahâmîd. Patches of efflorescent salts are found on exposed surfaces of the shale, the salts being principally the chloride, nitrate, and sulphate of soda; consequently, an impure nitrate manure consisting of shale with a mixture of sodium salts may be scraped up wherever this efflorescence occurs. This product is locally known as *tafla* and is transported without treatment direct to the fields. The average content of nitrate of soda, in the *tafla* as normally collected, is from 5 to 7 per cent, although patches of higher grade are found.

In the rare instances where pits or trenches have been made more than a metre into the exposed surface of the Isna shale, where rich efflorescences of salts occur, it has been observed that the nitrate values diminish and disappear. This fact appears to confirm the theory that nitrate salts are not regularly distributed throughout the shales even in minute quantities, but that the nitrate is formed by the action of bacteria on organic matter in the presence of moisture when the shale is exposed under suitable conditions.

The question of some form of concentration with separation of the salt contents has been incompletely examined at various times. There is no doubt that an impure nitrate of soda can be produced by lixiviation and evaporation, but the cost of transporting the shale from all directions to a central treatment plant where water is available is against the practical application of such a process.

The *tafla* is largely collected and brought by camels to the Nile Valley either to be sold or used on land owned by the fellahîn who collect it. The Government exacts no royalty on this product and the productions returns how only the quantity brought in from part of one district which is served by a decauville tramway.

These nitrate-bearing shales have been examined and described very fully from an agricultural point of view by Mr. F. Hughes in his paper entitled, " The Occurrence of Sodium Salts in Egypt with Special Reference to Nitrate of Soda," 1906.

CHAPTER XIV.—**Various Minerals now unexploited.**

Copper.

Small occurrences of copper ores are known in the south of the Sinai Peninsula and at Abu Seyal and Hamamîd in the Eastern Desert. These were apparently worked by the ancient Egyptians and slag and crucibles have been found in the vicinity.

It seems probable that the ancients imported both copper and tin for the making of bronze.

No copper deposits large enough to be of any value at the present day have so far been discovered in Egypt.

Molybdenite.

The occurrence of molybdenite in small grains in granite near Gebel Belih was reported by Matthias in 1915.

Chromite.

Chromite or chrome iron ore was first reported by Stewart in 1904 as occurring in the Eastern Desert at Gebel Hagar Dungash. The mineral was found in the form of a vein some 25 centimetres wide in serpentine country rock. Analysis of a specimen gave 30·7 per cent chromium sequi-oxide.

No attempt has been made to exploit this occurrence, which is too small to be of commercial value.

Magnesite.

Magnesite, like asbestos, has been found as an alteration product in serpentine and occurs in small veinlets in the rock.

Talc.

Talc or steatite may be found in several localities where metamorphic schists occur. Steatite has been collected in the Eastern Desert since early times and at the present day is cut and fashioned into bowls, tobacco pipes, etc., by the Arabs.

At the close of the war, when there was difficulty in importing talc to Egypt, an old working at Hamr near Aswân was reopened by Messrs. Blattner, who produced 137 tons in 1918.

Good quality talc is also found near Gebel Fatira. The high cost of transport prevents both these mines being profitably worked in normal times when Italian talc can be shipped cheaply to Alexandria.

Asbestos.

Asbestos has been found in many places in connection with serpentine rock and prospecting shafts and trenches have been made at Gelaib, Wadi Allagi and near the Barramia gold mine. The veins, however, were small and either pinched out or yielded only asbestos of inferior quality and of little or no commercial value.

Beryl-Emerald.

Beryl is found in the Sikait-Zubara region of the Red Sea hills round lat. 20°·40 N.

The district shows abundant evidence of mining activity in the past; the hillsides are honeycombed with ancient workings and the ruins of many houses and rock temples still exist.

The mineral occurs in hexagonal crystals embedded in mica and talc schists. These schists lie between gneiss below and serpentine above. Most of the crystals are pale whitish-green, full of flaws and unfit for jewellery, but occasionally the colour is darker and the stones may be classed as inferior emeralds. The pale blue type of beryl known as aquamarine appears to be absent.

The age of the old workings has not been established, but their greatest activity was probably in Greco-Roman times.

Two attempts have been made during the past century to rework the emerald mines: by Caillaud in 1817 and by Streeter between 1899 and 1905. Neither was commercially successful.

Turquoise.

Turquoise is known to have been mined in Sinai since very early times, princiaplly at Serabit el Khadem and at the Wadi Moghara. Many inscriptions describing expeditions sent by the Egyptian kings to the mines are found in the Wadi Mokateb, near Moghara.

The local tribes at the present day exploit the mines from time to time on their own account, and bring the stones to Egypt for sale.

In 1900 an English Company attempted to work the mines systematically, but appears to have failed, chiefly owing to the difficulty of supervision and prevention of theft.

The main workings extend for about two kilometres on the west side of Wadi Moghara.

The various names such as El Sade, El Yahudia, El Hejija, Um Hussein and El Hedeib are merely the local names of the different entrances in the hillside.

The formation is a purplish grey sandstone of carboniferous age capped with basalt, and the turquoise occurs in two hard ferruginous seams which lie horizontally in the sandstone about 2½ metres apart. These seams vary between ⅛ inch, when they are hard and compact, and several feet in thickness, when they are soft and the iron coloration remains the only guide to the turquoise-bearing zone. The turquoise is found either filling joints and cracks or in small concretionary nodules. The stones are of variable quality and the production is small.

Amethyst.

Ancient workings for amethyst have been found near Gebel Abu Diyeiba in the Safaga district. The amethystine quartz crystals occur in the cavities of a drusy red granite.

Sulphur.

Sulphur is widely distributed in connection with the vast deposits of gypsum and anhydrite which form one of the chief features of the Red Sea littoral. About 1865, a concession, which has since lapsed, was granted for working sulphur at Gemsa, where cave-like workings and ruins of kilns may still be seen.

The distribution of sulphur in gypsum is, however, so irregular and scattered that it is doubtful whether extraction could be commercially profitable.

Iron pyrites has been searched for on several occasions and has been noted in small quantities at Ranga and elsewhere, but no large deposit has yet been discovered in Egypt.

Lignite.

Several attempts have been made from time to time to find lignite or coal in commercial quantities, but so far without success.

The researches made show that the existence of coal of economic value in Egypt is highly improbable. Very thin seams of bituminous and carbonaceous material have been found in several different places in shales associated with the Nubian sandstone of cretaceous age.

Barytes.

Veins of barytes are found in granite associated with hæmatite at Gebel el Urf, and the mineral also occurs in the Nubian sandstone at the Baharia Oasis.

Celestine.

Specimens of celestine have been found in the Moqattam Hills south-east of Cairo.

CHAPTER XV.—**The Quarrying Industry.**

Historical.

The numerous ruins of temples, buildings and statues which are found throughout Egypt at the present day show that the ancient Egyptians were skilled in the art of quarrying.

It is recorded that the art was highly encouraged and that those engaged in quarrying occupied an important position in the national life. The special skill of some master quarryman was duly appreciated and he would, as a guarantee of the quality of the stone, brand with a trade mark the material extracted under his direction.

Records, too, exist of an expedition by Ramses II when he discovered basalt and chose the granite of Elephantine Island at Aswân for his colossi.

A quarry near Ma'sara was specially reserved for the gods and the kings' temples, and a stele bearing the decree warning trespassers and giving details of the boundaries of the reserve may be seen to-day.

Apart from Greek and Roman records no further traces of interest in quarrying exist, and it is presumed that until modern times stone was either obtained in a haphazard way from the old quarries or taken from ancient buildings.

At the present day the industry is extensively carried on throughout Egypt and large quantities of stone are quarried for building construction, roads, irrigation works, railway ballast, and lime burning.

Organisation.

The quarrying industry is practically confined to local enterprise, and in this way differs from the mining industry, whose capital and organization is chiefly foreign. With a few exceptions the methods employed in quarrying are primitive and have not kept pace with modern ideas and appliances. Thus the tendency has been to work the softer and inferior stone rather than the more durable but less easily extracted hard varieties. Gradual improvement has, however, been made of late years and it is hoped to continue this by the encouragement of more up-to-date and economical methods.

Until 1910 the administration of quarries was subdivided among various Government Departments. Most of these Departments required stone for their own work and when these requirements were fulfilled further interest in other quarries tended to assume very secondary importance.

During the period 1909–1912 the Department of Mines gradually assumed the administration of the quarries for all Egypt, and the work of re-organization has been steadily carried on ever since. Various regulations have been introduced with a view to ensuring uniform and fair treatment to quarrymen and obtaining a more adequate return to the State.

Distribution and Nature of Quarries.

Product.	Locality.	Purposes for which employed.
Limestone	Mex, Suez, Cairo, Upper Egypt.	Building stone, lime, cement, rubble.
Sandstone	Upper Egypt (south of Luxor); Gebel Ahmar, Cairo	Building stone, mill-stones, road metal.
Granite	Aswân...	Paving setts, ornamental stone.
Basalt	Abu Za'bal...	Road metal, paving setts, railway ballast.
Gypsum	Eastern Desert, between Cairo and Beni Suef, Faiyûm, Lakes Menzala, Maryût and Ballah.	Plaster of Paris.
Quartz...	Aswân...	Refractory material.
Gravel and sand	'Abbâsîya and elsewhere...	Various.
Clay	Gîza and Aswân Mudirîyas	Bricks, pottery, drain pipes.

The geographical distribution of Egyptian strata and economic products have been described by Dr. Hume in his " Explanatory Notes to accompany the Geological Map of Egypt," published by the Government Press.

The preceding table shows the various quarry products, the principal localities and the purposes for which the products are employed.

In order to facilitate administration and apply regulations suitable to varying local conditions the quarry groups are divided into four main districts : Upper Egypt, Cairo, Lower Egypt, and Mex.

Upper Egypt Quarries.

All these are within easy reach of the Nile, the railway, or canals and are thus afforded ample facilities for the transport of the stone.

The most important quarries are situated on the eastern bank of the Nile and the best are found at Garf el Deir and Gebel el Abiad in Minya Mudirîya, at Gebel Abu Foda and Gebel el Gharbi in Asyût Mudirîya, and at Gebel el Ahaywa in Girga Mudirîya.

The Upper Egypt district extends from Gîza Mudirîya southward to the Sudan border, but no quarries have been leased as yet further south than Shellal, where quarrying has up to the present been permitted free so that the inhabitants might rebuild their villages after the heightening of the Aswân dam.

Upper Egypt Quarry Group.

Mudirîya.	Locality.	Annual Rentals.
		L.E.
Faiyûm	Dimishqîn	2
Gîza	Abu Ruweish	2
	Deir el Maimûn ...	10
	'Ezbet el Haggâra ...	10
Beni Suef	Gebel el Mudil	15 to 35
	Bayâd el Nasâra ...	10
	Abu Sîr	8
Minya	Gebel el Abiad	30 to 35
	Gebel Garî el Deir ...	8 to 35
	Balansûra	20 to 35
	Bahnasa	13 to 15
Asyût	Asyût el Gharbi ...	10 to 30
	Durunka	20
	Abu Foda	21 to 32
Girga	Ahâywa	12 to 20
	Haridi	48
Qena	Mi'alla...	10 to 12
	Kolet el Qasr	8 to 12
Aswân...	Kubânîya	10

Cairo Quarries.

This district, which is the most important in Egypt and where skill in quarrying has reached its greatest development, is subdivided into twenty-one zones.

CAIRO QUARRY GROUP.

Locality—Gebel.	Annual Rentals.
	L.E.
Helwân	16
Ma'sara	9 to 30
Tûra	12 to 18
Haysum	8
'Ayûn Mûsa	22
El Raha	15
El Harif	8 to 27
Rimal el Basâtîn	10
El Tablîta	8
El Hashmi	8
El Amâra	13 to 32
Athar el Nabi	7 to 12
Batn el Bagara	9 to 42
'Ein el Sira	10 to 66
Zawiet Nassra	13 to 20
El Abiad	7 to 26
Meadissa	10 to 37
Dowaieqa	15
Rimal el 'Abbâsîya	24 to 40
El Ahmar	26 to 45
Rimal el Ahmar	20 to 40

Lower Egypt Quarries.

Lower Egypt consists mainly of the alluvium of the Nile and Delta and limestone quarries are only worked at Gebel el Mounayar and in the neighbourhood of the Suez Canal. Sand, gravel and gypsum are exploited near Ismailia, and at Abu Za'bal an occurrence of basalt is extensively worked.

Mex Quarries.

This district supplies stone for the city of Alexandria. The product is limestone of the Pleistocene period and though softer than the Eocene limestone of the Nile Valley it is an efficient building stone and burns to lime of good quality. The quarries are known locally as " Gebel " and " Fehera " quarries. The " Gebel " quarries are those on land above sea-level and are worked in the ordinary way with explosives. The " Fehera " quarries are below sea-level, no explosives are used and the stone is cut *in situ* into square blocks of varying sizes. The pits so formed are filled up on abandonment of the work.

The Mex quarries are leased on special conditions and at very low rents as compared with other districts. This is a necessary offset to the dues collected on quarry products by the Municipality of Alexandria.

In the case of stone quarries the area leased is normally 5,000 square metres. Clay, gypsum, and gravel areas vary in extent. Leases are issued for periods of one, five, and ten years. Rents vary according to the quality of the product and with the acessibility of the quarry.

Permits for the erection and maintenance of decauville rails, aerial ropeways and limekilns are issued in conjunction with quarry leases.

The important number of cases of theft of stone brought before the courts and the cancellaton of quarry leases by Ministerial Arrêtés for breach of regulations has resulted in effectively reducing cases of illicit and unlicensed quarrying. Since 1913, 618 cases of such misdemeanours were brought before the courts by the Department of Mines, which secured 391 convictions. 106 cases were filed for lack of sufficient evidence and 121 cases were acquitted.

Government Reserves.

A certain number of quarries are reserved for the use of contractors engaged on Government work. These quarries are either allotted to Government contractors, who pay a royalty on stone extracted, or are developed by the Government itself. The most important quarries directly worked by a Government Department are the Abu Za'bal basalt quarries and the Tûra limestone quarries, both in the charge of the Prisons Administration.

These selected Government quarry reserves serve two purposes, firstly that of securing the best stone available, and secondly in preventing the formation, by quarry workers, of a ring to raise the price of stone for public works.

Statistics.

At the beginning of 1922 there were 933 quarries being worked.

These included gypsum, clay and gravel zones and were distributed as follows :—

Upper Egypt	240
Cairo	210
Lower Egypt	62
Mex	421

The total number of persons directly engaged in quarrying is estimated at 8,047.

The total output of quarry products is estimated at 1,500,000 cubic metres per year. During 1921, 300,000 cubic metres were supplied from the Government reserves.

The revenue obtained from quarries during later years is as follows :—

	L.E.
1910	1,803
1914–1915	3,084
1918–1919	4,375
1919–1920	6,204
1920–1921	8,402
1921–1922	9,600

CHAPTER XVI.—**Bibliography.**

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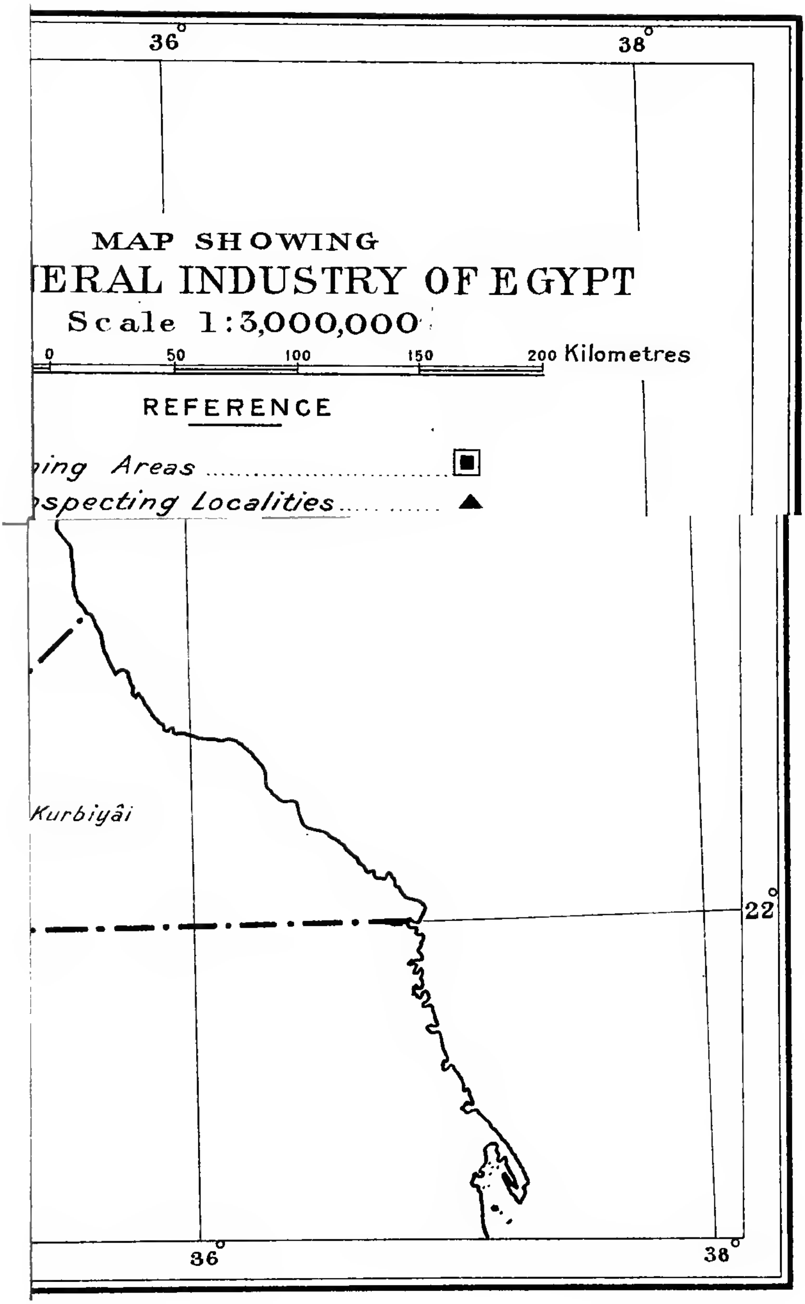
MINERAL PRODUCTION OF EGYPT.

Year.	Phosphate Rock.	Petroleum.	Manganese Iron Ore.	Lead and Zinc Ores.	Nickel Ore.	Gold (fine).	Peridots. Value.	Nitrate Shale.*	Carbonates and Sulphate of Soda.	Ochre.	Sulphate of Alumina.	Sulphate of Magnesia.
Unit.	Met. Tons.	Met. Tons.	Met. Tons.	M. Tons.	M. Tons.	Ozs.	L.E.	M. Tons.	Met. Tons.	M. Tons.	M. Tons.	M. Tons.
1907	*Nil.*	*Nil.*	*Nil.*	*Nil.*	*Nil.*	4,916	*Nil.*	*Nil.*	*Nil.*	*Nil.*	*Nil.*	*Nil.*
1908	700	,,	,,	,,	,,	1,843	,,	,,	,,	,,	,,	,,
1909	1,000	,,	,,	,,	,,	2,900	,,	,,	,,	,,	,,	,,
1910	2,397	,,	,,	,,	,,	4,452	10,780	,,	,,	,,	,,	,,
1911	12,013	2,793	,,	,,	,,	5,068	12,320	,,	,,		,,	,,
1912	70,918	27,962	,,	3,510	75	4,958	15,330	4,939	,,	,,	,,	,,
1913	104,450	12,786	,,	7,156	*Nil.*	4,602	6,930	4,740	,,	,,	,,	,,
1914	71,945	99,680	,,	4,909	233	6,136	9,590	3,370	,,	,,	,,	,,
1915	82,998	30,054	,,	2,988	*Nil.*	7,096	*Nil.*	4,271	,,	,,	,,	,,
1916	125,008	57,743	,,	*Nil.*	,,	6,287	,,	3,950	,,	,,	,,	,,
1917	115,732	136,845	,,	,,	,,	3,319	,,	4,347	3,527	,,	,,	,,
1918	31,147	281,885	27,498	,,	,,	2,856	,,	4,520	3,486	212	168	390
1919	29,365	224,300	48,734	,,	,,	1,948	,,	3,940	1,431	44	54	269
1920	114,813	147,950	77,562	,,	,,	128	,,	4,743	1,981	231	*Nil.*	266
1921	122,024	182,668	55,065	,,	,,	*Nil.*	,,	3,656	563	430	,,	115

* Partial production; complete returns not available.



MAP SHOWING

ERAL INDUSTRY OF EGYPT

Scale 1:3,000,000

0
50
100
150
200 Kilometres
REFERENCE
ing Areas .... ■
specting Localities .... ▲
36°
38°
Kurbiyâi
22°
36°
38°